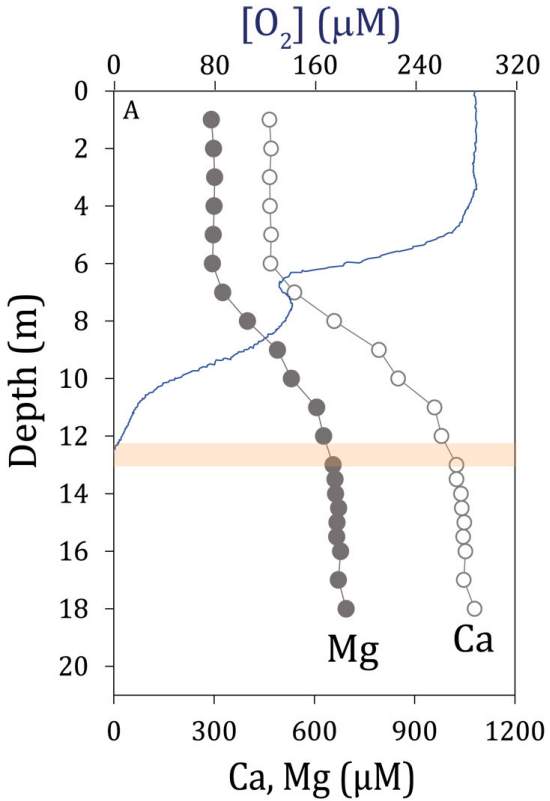
Meret Aeppli

Water column



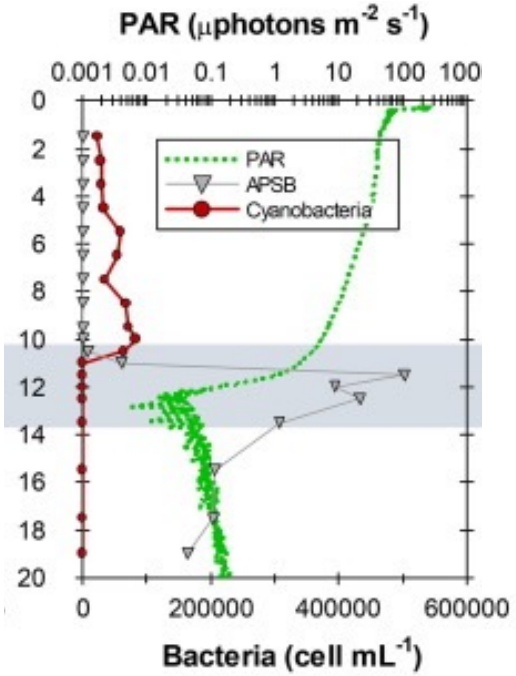
The chemocline separates the upper, oxygenated layer (above 13 m depth) and the lower, anoxic layer (below 13 m depth).

a. Why do bottom waters become anoxic?

b. What differences in water chemistry do you expect for these two layers?

*Janssen, DJ et al., AGU Geophys Res Let, **2022**, 49, e2022GL099154.*

Water column



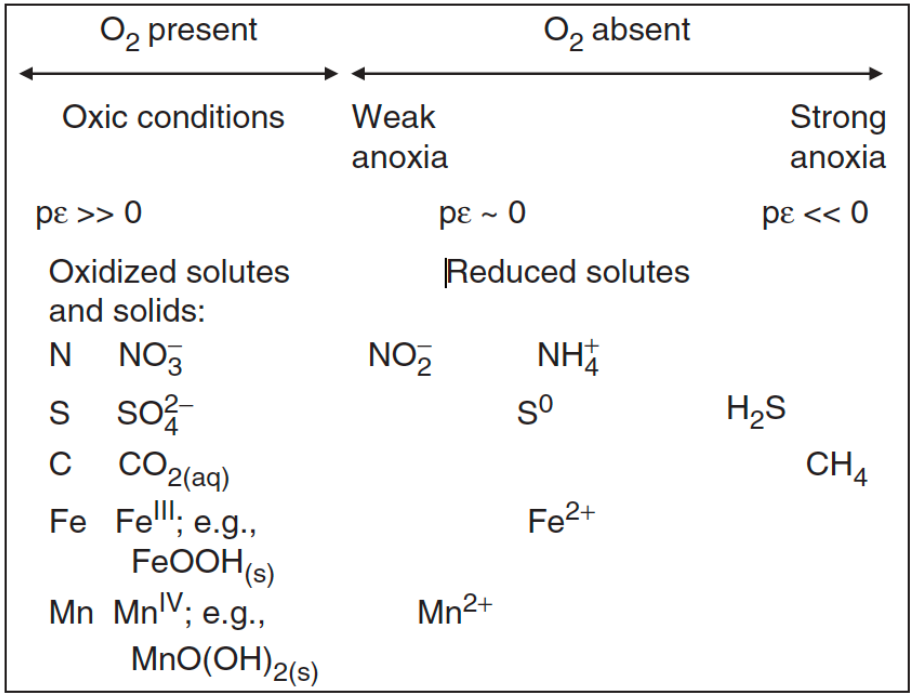
Why do bottom waters become anoxic?

- High primary production in the surface layer (cyanobacteria)
- Formed organic matter sinks downward and is degraded in the chemocline and below
- Step-wise consumption of electron acceptors

PAR = photosynthetically active radiation
APSB = anaerobic phototrophic sulfur bacteria

*Ellwood, MJ et al., Geochim Cosmochim Acta, **2019**, 255, 205-221.*

Water column



What variations in water chemistry do you expect for these two layers?

- Oxic layer: oxidized solutes and solids
- Anoxic layer: elevated concentrations of reduced Mn, Fe, H_2S

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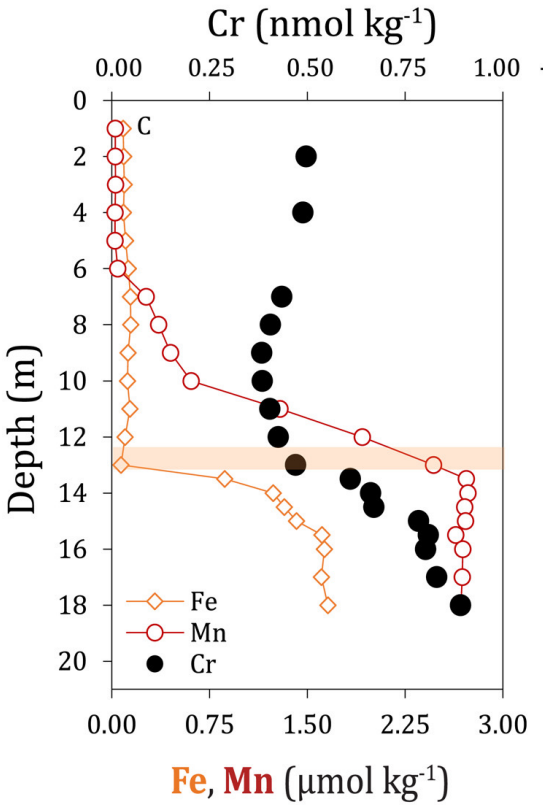
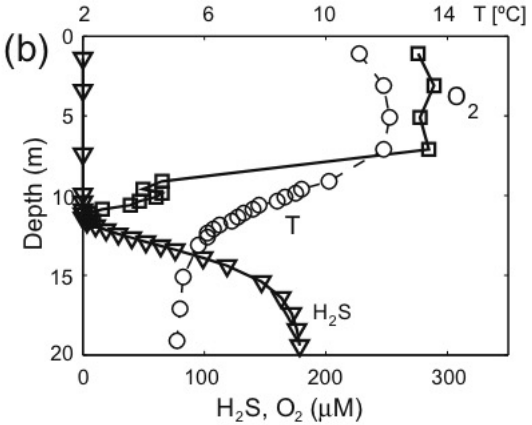
Water column



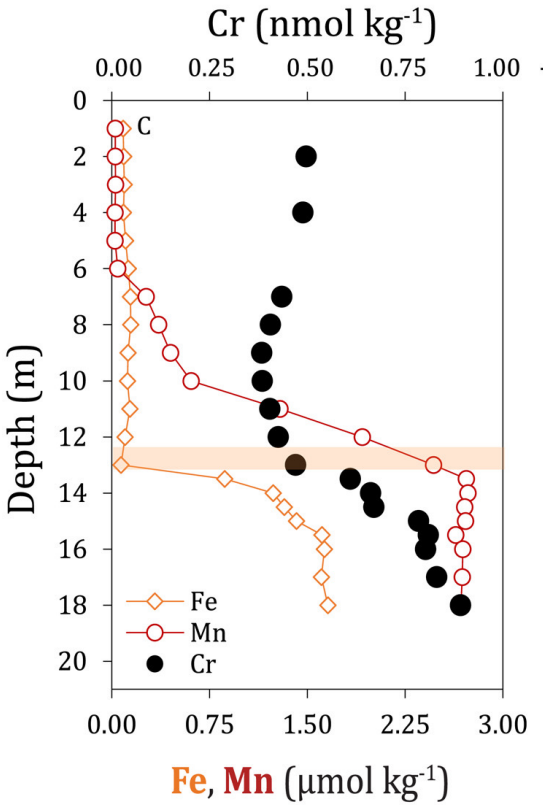


Do concentration profiles follow the expected redox sequence?

Yes: coming from the water surface, we first observe O_2 reduction, followed by Mn reduction, Fe reduction, and finally sulfate reduction (the product of which is H_2S)

Janssen, DJ et al., AGU Geophys Res Let, ***2022****, 49, e2022GL099154. Dahl, TW et al., Geochim Cosmochim Acta,* ***2010****, 74, 144-163.*

Water column



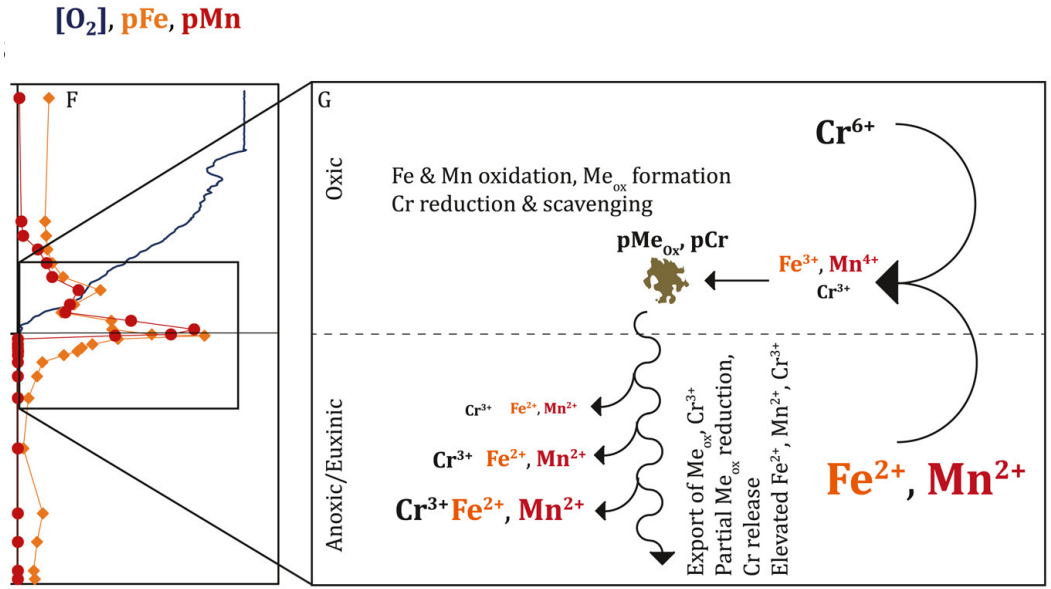
We can explain the Fe and Mn trends with the redox profile. But what about Cr?

Cr likely comes into the lake through surface water input resulting from oxidative terrestrial weathering.

Which processes could result in these trends in concentration?

Janssen, DJ et al., AGU Geophys Res Let, ***2022****, 49, e2022GL099154.*

Redox processes at the chemocline

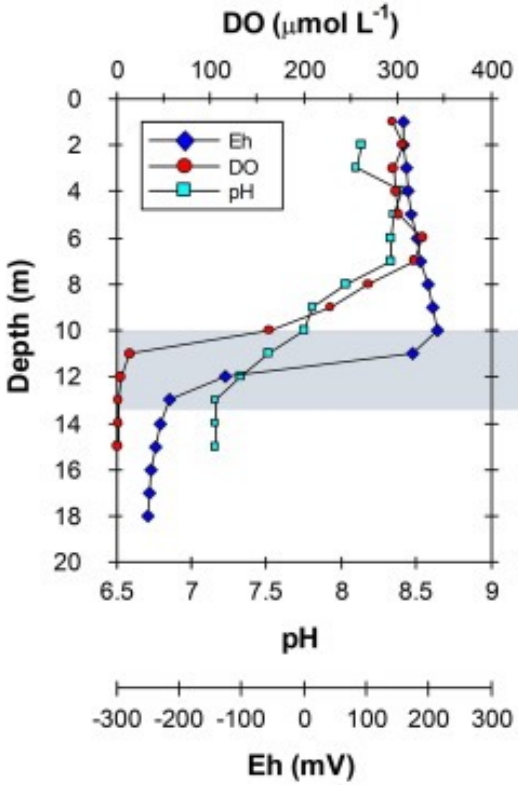


- Fe and Mn oxides form within and above the chemocline, driven by upward transport of dissolved Fe(II)
- Fe(II) reduces Cr from Cr^{6+} to Cr^{3+}
- Cr^{3+} is scavenged onto metal oxides
- Sinking particles transport Cr^{3+} down- reductive dissolution of iron oxides results in release of Cr

Janssen, DJ et al., AGU Geophys Res Let, ***2022****, 49, e2022GL099154.*

Iron redox processes

- The decrease in dissolved and increase in particulate Fe concentrations suggest that iron phases are precipitating.
- Which method could you use to figure out which phases are precipitating?



Ellwood, MJ et al., Geochim Cosmochim Acta, ***2019****, 255, 205-221.*

E_H-pH stability diagram to the rescue!

Which parameters do you need? (These are given in the paper referenced below)

- Temperature: 5.5 °C
- Pressure: 1 bar
- Total iron concentration: 1 mmol/L
- Bicarbonate: 1 mmol/L
- Calcium: 1 mmol/L
- Sulfate: 3 mmol/L
- Phosphate: 3 µmol/L

*Ellwood, MJ et al., Geochim Cosmochim Acta, **2019**, 255, 205-221.*

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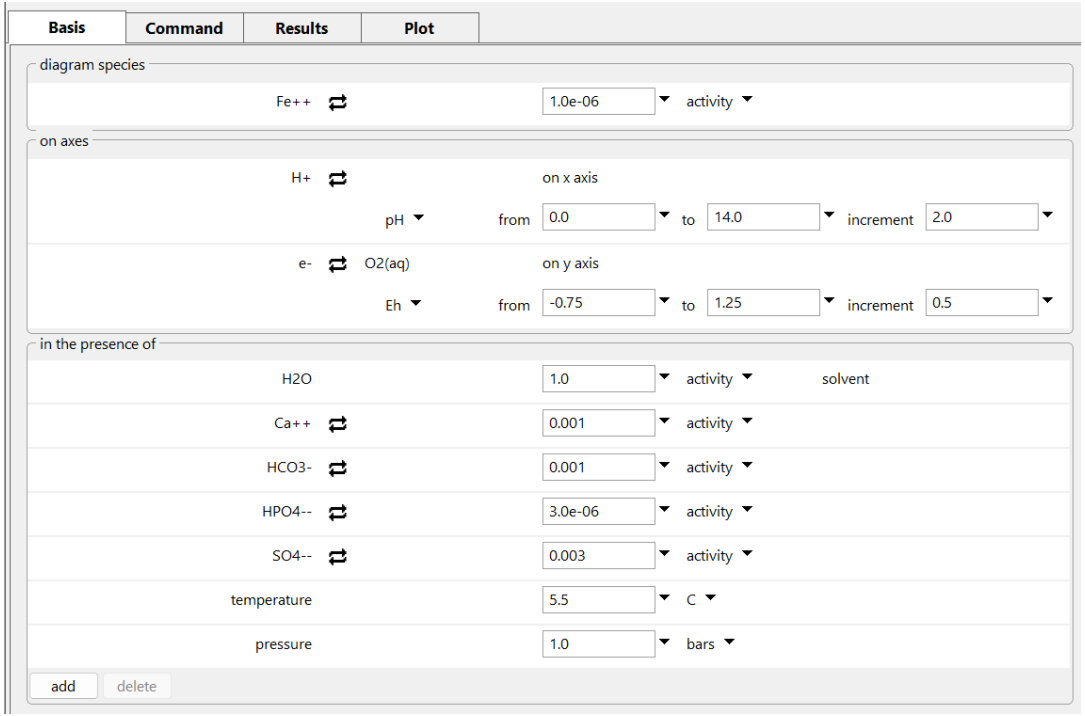
E_H-pH stability diagram: Solution



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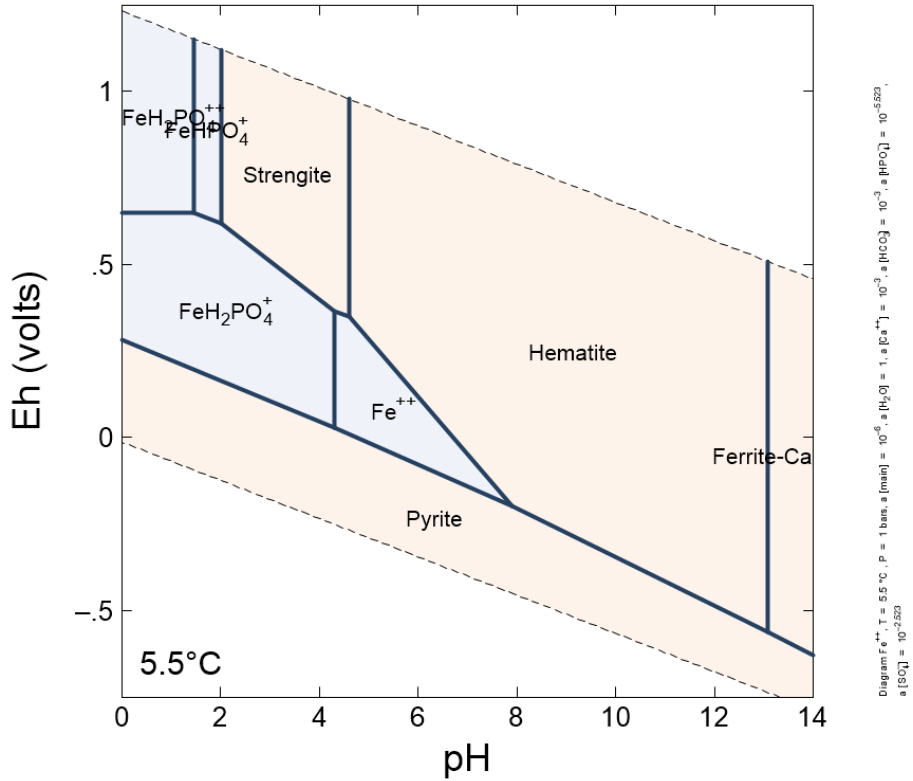
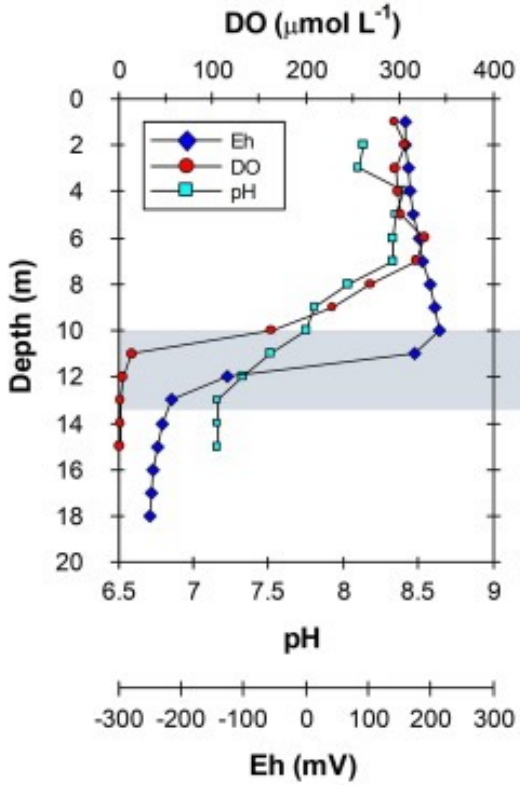
E_H-pH stability diagram: Solution



E_H-pH stability diagram: Solution

- Now add the data from the figure on the right into your E_H-pH diagram.
- To do so, create a GSS file, add the data, and then drag and drop it into your E_H-pH diagram.



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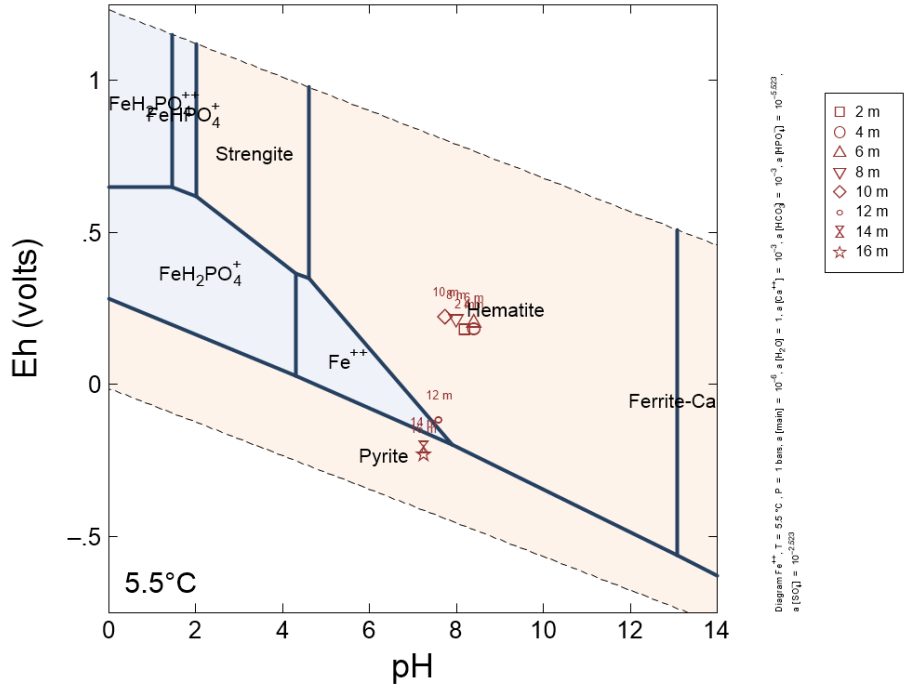
E_H-pH stability diagram: Solution



FeS is expected to precitipate in the anoxic zone and likely causes the increase in particulate concentrations we observed.